CLAIMS

What is claimed is:

1. An atomic layer deposition (ALD) process, comprising exposing a wafer to a first chemically reactive precursor dose insufficient to result in a maximum saturated ALD deposition rate on the wafer, and exposing the wafer to a second chemically reactive precursor dose, wherein said precursors are distributed in a manner so as to provide substantially uniform film deposition.

2. The ALD process of claim 1, wherein the second chemically reactive precursor dose is insufficient to result in a maximum saturated ALD deposition rate on the wafer.

3. The ALD process of claim 1, wherein the second chemically reactive precursor dose is sufficient to result in a starved saturating deposition on the wafer.

4. The ALD process of claim 1, wherein the wafer is exposed to the second chemically reactive precursor dose without a purge following exposure to the first chemically reactive precursor dose.

5. The ALD process of claim 1, wherein the wafer is again exposed to the first chemically reactive precursor dose without a purge following exposure to the second chemically reactive precursor dose.

6. The ALD process of claim 1, wherein the wafer is again exposed to the first chemically reactive precursor dose without a purge following exposure to the second chemically reactive precursor dose and then again exposed to the second

chemically reactive precursor dose without a purge following exposure to the first chemically reactive precursor dose.

7. The ALD process of claim 6 wherein the wafer is exposed to the first chemically reactive precursor dose for a time period providing for a substantially maximum film deposition rate.

8. The ALD process of claim 1, wherein a purge is performed subsequent to exposing the wafer to the first chemically reactive precursor dose.

9. The ALD process of claim 1, wherein a purge is performed subsequent to exposing the wafer to the second chemically reactive precursor dose.

10. The ALD process of claim 1, further comprising exposing the wafer to a third or more chemically reactive precursor dose(s), at least one of which is not sufficient to result in a saturating deposition on the wafer.

11. The ALD process of claim 1, wherein one of the first and second chemically reactive precursor doses comprises water (H_2O) and the other comprises Trimethylaluminum (TMA).

12. The ALD process of claim 1, wherein the wafer is at a temperature between approximately 150 °C and approximately 450 °C.

13. The ALD process of claim 1, wherein the wafer is located in an environment at a pressure between approximately 10 mTorr to approximately 1 Torr.

14. The ALD process of claim 6, wherein the wafer is located in an environment at a pressure between approximately 50 mTorr to approximately 500 mTorr.

15. The ALD process of claim 1, wherein one or both of the first and/or second chemically reactive precursor doses is applied for a time between approximately 0.02 sec to approximately 2 sec.

16. The ALD process of claim 6, wherein one or both of the first and/or second chemically reactive precursor doses is applied for a time between approximately 0.02 sec to approximately 0.5 sec.

17. The ALD process of claim 1, wherein the first and the second chemically reactive precursor doses are delivered substantially uniformly over the wafer.

18. The ALD process of claim 1, further comprising repeatedly exposing the wafer to the first and second chemically reactive precursor doses to form a material film on the wafer.

19. An atomic layer deposition (ALD) system, comprising a precursor delivery system configured for exposing a wafer to a first chemically reactive precursor dose insufficient to result in a maximum saturated ALD deposition rate on the wafer, and to a second chemically reactive precursor dose, said first and second doses being applied in a manner so as to provide substantially uniform film deposition on said wafer

20. The ALD system of claim 19, wherein one or both of the first and/or second chemically reactive precursor doses are applied for a time between approximately 0.02 to approximately 2 seconds.

21. The ALD system of claim 19, wherein the precursor delivery system includes an axi-symetric precursor injector and a precursor distribution plate positioned between the precursor injector and a susceptor configured to support the wafer.

22. The ALD apparatus of claim 21, wherein the precursor distribution plate includes a series of annular zones about a center thereof, each of said zones being configured with a greater number of precursor distributors than an immediately preceding zone as viewed from the center of the precursor distribution plate.

23. The ALD apparatus of claim 19, wherein the precursor delivery system includes a diffuser plate configured so as to permit chemically reactive precursors passing therethrough to remain randomized in their trajectories towards the wafer when the ALD system is in operation.

24. The ALD apparatus of claim 19, wherein the precursor delivery system includes a dome-, cone- or horn-shaped chemical distribution apparatus.

25. A sequential chemical vapor deposition (CVD) process, comprising alternatively exposing a wafer to a dose of a first chemically reactive precursor and a dose of a second chemically reactive precursor, wherein at least the second chemically reactive precursor exhibits saturating characteristics, and the dose of the first chemically reactive precursor is selected so a film growth rate is substantially at a maximum value.

26. The sequential CVD process of claim 25, wherein said first and second precursors are distributed in a manner so as to provide substantially uniform film deposition.

27. The sequential CVD process of claim 25, wherein there is no delay between the does of the two alternating precursor exposures.

28. The sequential CVD process of claim 25, wherein the wafer is exposed to the dose of the second precursor so as to achieve its saturation on the wafer.

29. The sequential CVD process of claim 25, wherein one of the first and second chemically reactive precursor doses comprises water (H_2O) and the other comprises Trimethylaluminum (TMA).

30. The sequential CVD process of claim 25, wherein the wafer is at a temperature between approximately 150 °C and approximately 450 °C.

31. The sequential CVD process of claim 25, wherein the wafer is located in an environment at a pressure between approximately 50 mTorr to approximately 500 mTorr.

32. The sequential CVD process of claim 25, wherein one or both of the first and/or second chemically reactive precursor doses is applied for a time between approximately 0.02 sec to approximately 1.0 sec.

33. The sequential CVD process of claim 25, further comprising repeatedly exposing the wafer to the first and second chemically reactive precursor doses to form a material film on the wafer.

34. A chemical vapor deposition (CVD) apparatus, comprising a precursor delivery system configured to alternately expose a wafer to a dose of a first chemically reactive precursor selected so a film growth rate is substantially at a maximum value and a dose of a second chemically reactive precursor, at least the second chemically reactive precursor exhibiting saturating characteristics.

35. The CVD apparatus of claim 34, wherein one or both of the first and/or second chemically reactive precursor doses is applied for a time between approximately 0.02 sec to approximately 1.0 sec.

36. The sequential CVD apparatus of claim 34, wherein the precursor delivery system includes an axi-symetric precursor injector.

37. The sequential CVD apparatus of claim 36, wherein the precursor delivery system includes a dome-, cone- or horn-shaped chemical distribution apparatus.

38. The sequential CVD apparatus of claims 34, wherein the precursor delivery system includes a showerhead.

39. The ALD system of claim 19, wherein the precursor delivery system includes a showerhead.